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DEVELOPMENT OF A BACKPACK SURVIVAL KIT FOR EJECTION SEATS

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The Navy is designing a Backpack Survival Kit (BSK) for ejection seats. Expected advantages of the BSK as compared to seat lid kits are less weight and more crewmember mobility during emergency egress from aircraft cockpits. With development of more sophisticated ejection propulsion systems, volume for survival kit stowage under the seat lid may not be available; the BSK offers an alternative stowage location. Design considerations include integration into the ejection seat system, attachment to the crewmember's restraint harness, stowage of survival gear, liferaft deployment, and crewmember mobility.

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TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The Life Support Engineering Division, Aircraft and Crew Systems Technology Directorate, is investigating the feasibility of a Backpack Survival Kit (BSK) for ejection seat systems. The expected advantages of such a kit as compared to seat lid kits are lower weight and more crewmember mobility for emergency egress from the aircraft.

Also, in recent years, some ejection system research and development efforts have focused on the development of rocket propulsion using thrust vector control (TVC). The TVC rocket with its supporting logic and control hardware is likely to occupy the stowage volume under the seat lid where the survival kit and fixed nozzle rocket are now located on many ejection seats. For TVC ejection systems, the BSK may have to be used in place of seat lid survival kits.

DESIGN REQUIREMENTS

The BSK is designed to meet the following requirements:

- As a minimum, the BSK shall contain an emergency breathing oxygen bottle with pressure reducer, a liferaft, radio beacon, drinking water, compass, two flares, two sea dye markers, two light sticks and 50 feet of nylon rope.
- The BSK shall be carried by the crewman's parachute restraint harness after seat/man separation and shall withstand a 30 G parachute opening shock.
- The BSK shall protect its contents when a load of 12.8 psi (0.90 Kg/cm^2) is distributed over its front panel.
- The BSK shall have a manual actuation handle to deploy the liferaft during parachute descent.
- The BSK shall have a manual actuation handle for activating the emergency breathing oxygen.
- The BSK design shall allow for lanyard initiation of the radio beacon at the time of ejection.
- The BSK shall be designed for safe and effective seat/man separation.
- The BSK shall be designed without any features which may injure the crewmember during parachute descent and landing.
- The BSK material shall be durable and shall not chip or crack during normal flight and maintenance operations.

Maintenance requirements include:

- The parachute restraint harness/BSK attachment fittings shall be quick disconnect fittings to allow for quick removal of the BSK from the harness.

- The BSK design shall allow for access for replacing the radio beacon battery within one minute.

- The BSK design shall allow for a removal and replacement maintenance action of any kit item to be performed within two minutes.

DESIGN APPROACH

The current design phase has placed an emphasis on the design problems involving (1) location and attachment of the BSK on the seat and crewmember, and (2) deployment of the liferaft by the crewmember during parachute descent. Experimental BSK models have been fabricated of a fiberglass laminate composed of glassmat and polyester resin. The process for fabricating the models was a hand-layup method. A compression molded BSK is ultimately preferred to achieve the structural integrity stated by the design requirements. As a comparison, tensile strength for the fiberglass mat-resin composite material is approximately 9000 psi (633 Kg/cm^2) whereas the tensile strength for the same material fabricated by compression molding is approximately 25,000 psi (1759 Kg/cm^2).

Selection of an ejection seat platform and ejection system impacts the design of a BSK since the BSK must be designed to integrate or interface with the seat, man and other system components. For the current development phase, the BSK is being incorporated into the experimental Navy Maximum Performance System (MPES), which has TVC propulsion. Therefore, some portions of the design of the BSK in this investigation may be considered unique to the MPES and other portions of the design would be common to any ejection seat. For example, every BSK must have a raft deployment actuation handle, but each BSK may have a shape tailored to its particular model of ejection system. Figure 1 shows the shape of an experimental BSK model as designed for MPES. The bulge on the back of the BSK is a design feature unique to the MPES as it protrudes through the MPES seat back panel increasing the total volume of the kit.

1. ATTACHMENT OF BSK TO TORSO RESTRAINT

The BSK can be designed to mount on the crewmember's back, as shown in Figure 1, for emergency egress or to drop down behind the crewmember's upper legs as shown in Figure 2. The second approach resembles the configuration of current seat lid survival kits.

The BSK configuration of Figure 1 is expected to offer the crewmember more maneuverability during escape. This design would also complement the Navy's development of an encapsulating liferaft. To encapsulate the crewmember during parachute descent, the packaged raft must begin deploying while attached to the crewmember's back.

The back-mounted BSK requires attachments to the torso restraint/parachute harness at the upper back and at the lower back. Caution must be taken in designing the upper attachment; the crewmember requires fore-and-aft movement of his upper body during aircraft operations. Therefore, the BSK is not attached to the crewmember's upper back during flight operations. For the MPES design, the inertia reel straps are routed through a snubber mechanism near the top of the BSK. The snubber mechanism is kept open to allow freedom of movement for the crewmember. When ejection is initiated, the inertia reel pulls the crewmember back against the BSK. Just prior to seat/man separation, the snubber mechanism is closed to "grab" the inertia reel strap. The BSK is now restrained on the crewmember's back by means of the inertia reel strap and the lower torso restraint strap attachment points. (For the MPES design, the inertia reel straps are severed with a

Figure 1. Backpack Survival Kit (BSK) Experimental Model

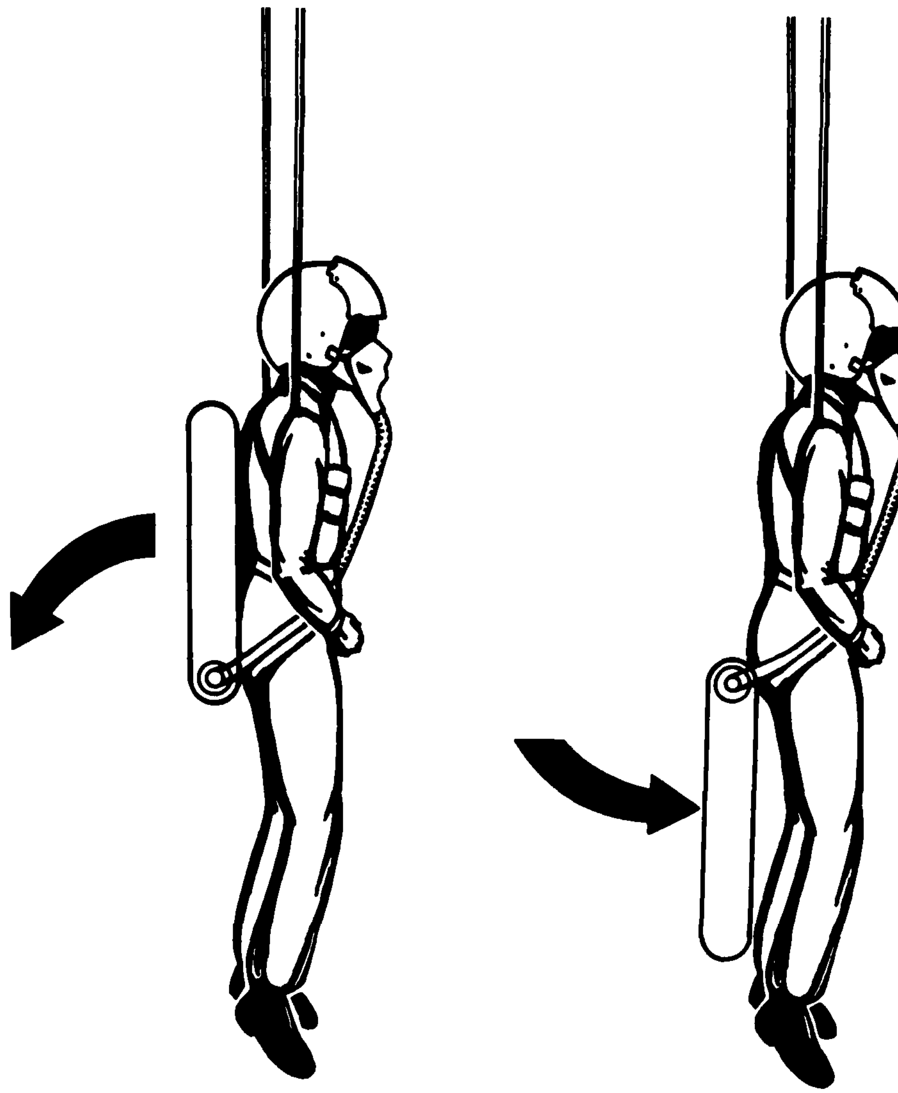

Figure 2. BSK Drop-Down Concept

ballistic-actuated strap cutter. The strap cutter also cuts a strap which releases the spring-loaded snubber mechanism into a locking—"snubbing"—position.)

The second design approach, shown in Figure 2, would require only the lower attachment points. This design would be used in conjunction with current life support/survival gear.

For the lower attachments, two short straps (one on each side of the BSK) connect the BSK to the crewmember's lap belt. If the crewmember keeps his lap belt adjusted comfortably tight, then his hips should not move away from the BSK during aircraft operations. Thus, the lower attachment straps need be only several inches in length and not inhibit hip/pelvis movement in the seat.

The relative lack of fore-and-aft movement of the crewman's lower back also allows the BSK to be placed against the back panel of the seat structure without using any BSK-to-seat structure attachments. The BSK is kept in place by the weight of the crewmember sitting against it. Figure 3 shows the crewmember in a normal sitting position with his back pressing against the BSK. In Figure 4 the crewman is moving forward. Even as he bends forward his lower back presses against the BSK. (Figure 4 also illustrates why a fixed short strap attachment at the upper back cannot be used for the back-mounted BSK as previously discussed.) Unwanted movement of the BSK is more likely to occur in the lateral direction. This problem is easily solved through the use of frictional interfaces, stops, sticker clips and other types of mechanisms. However, it should be noted that whatever approach is taken to prevent the lateral movement, the lateral restraint mechanism(s) should not hinder seat/crewmember separation during ejection.

Seat/crewmember separation during ejection must also be considered in the design of the BSK and of other seat components. As a matter of fact, the shape of the ejection seat headrest may be more critical than the design of the BSK for the performance of the seat/crewmember separation event. The lower portion of the headrest can be sloped to allow the BSK to slide over it as the man is pulled out of the seat by his parachute.

2. STOWAGE OF SURVIVAL GEAR AND BREATHING OXYGEN

The survival gear can be arranged in the BSK in a number of ways. For the preliminary development effort the survival gear was arranged in the BSK as shown in Figures 5 and 6. The gear stowed in the compartment in the back panel is shown loosely packed; in reality, this gear is enclosed in a pouch or vacuum sealed pack. (The compartment in the back panel is a design feature which is unique to MPES.)

The radio beacon has been placed against the front panel of the BSK. There is a cutout (not shown) on the front panel which allows for access to the radio beacon for replacement of its battery. The beacon actuation lanyard is routed through the back of the BSK to a floor attachment in the cockpit.

The emergency breathing oxygen bottle and pressure reducer (not shown) are located in the bottom portion of the BSK. In this location the emergency breathing oxygen supply lines can merge with the oxygen supply lines which run from the aircraft on-board oxygen to the crewmember's oxygen mask.

The liferaft is packed and stowed in the upper portion of the BSK. To deploy the raft the crewman must pull the raft deployment handle located on the lower right side of the BSK. Pulling the handle releases the back panel of the BSK. During parachute descent the falling back panel pulls the raft from the BSK and actuates the inflation of the raft as shown in Figure 7.

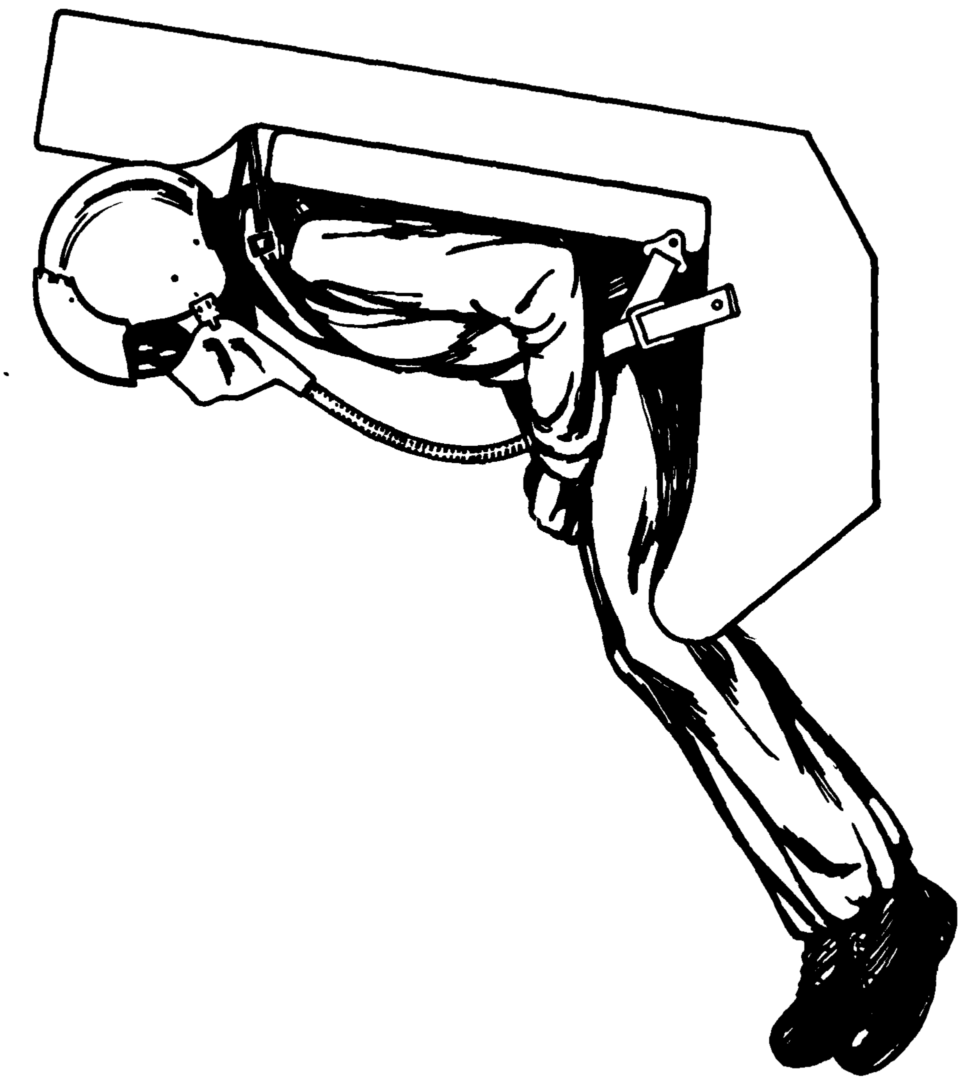

Figure 3. Crewmember/BSK/Seat Arrangement

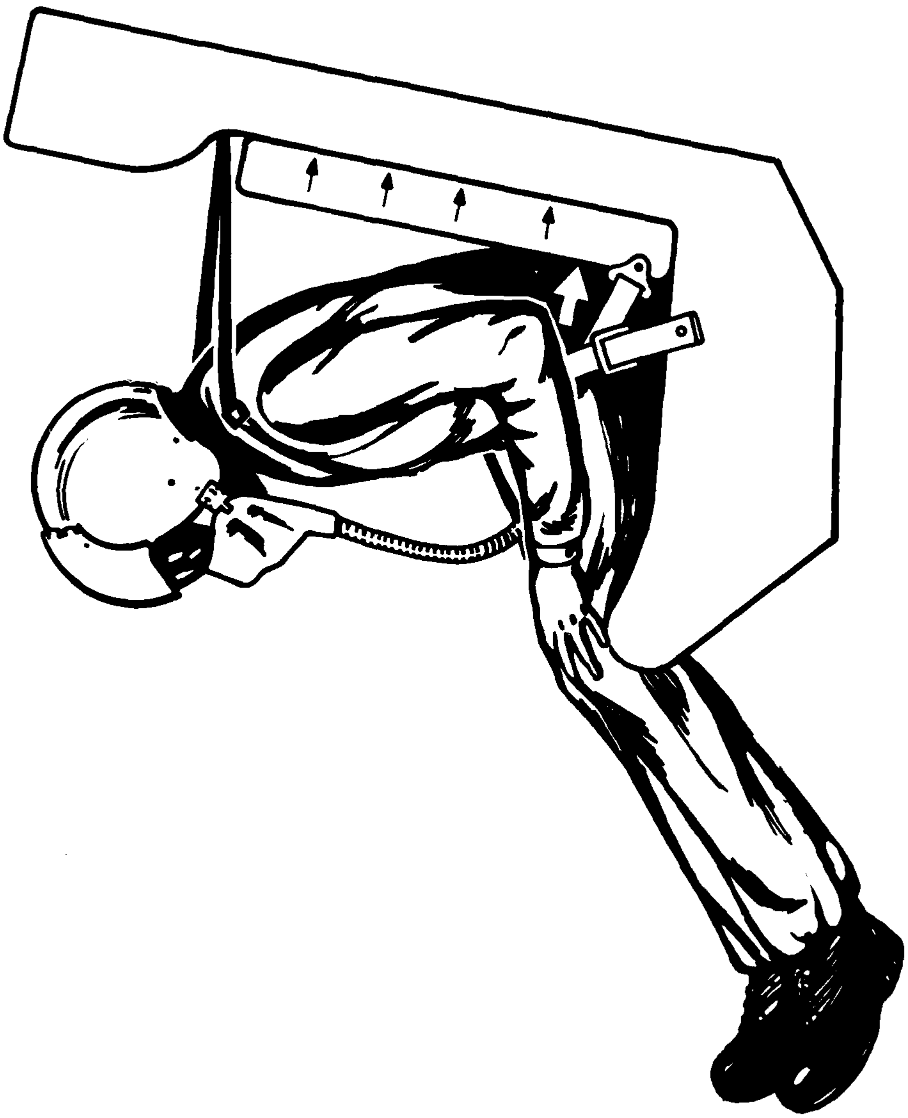

Figure 4. Crewmember/BSK/Seat Interaction With Crewmember Leaning Forward

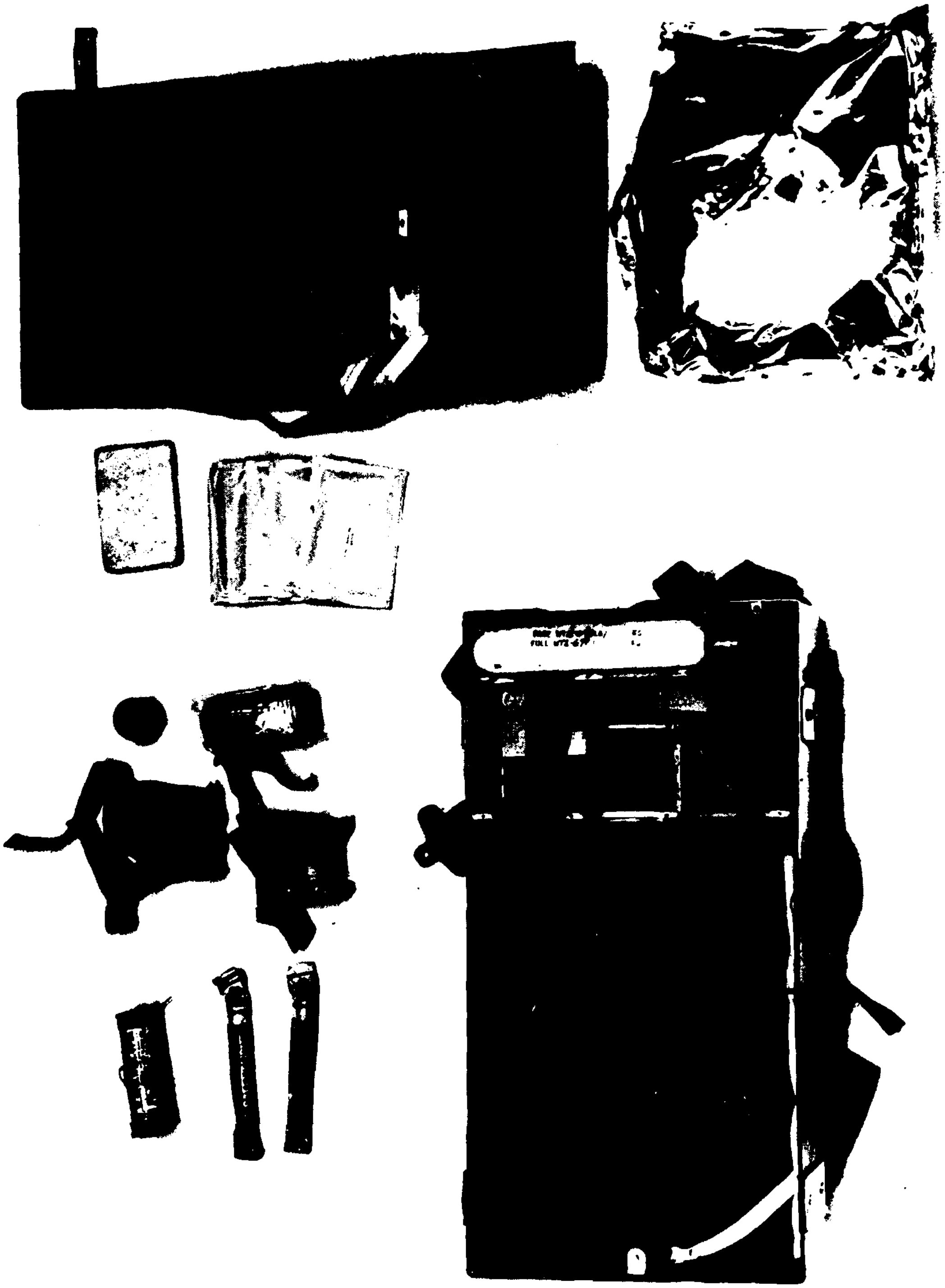

Figure 5. Layout of Survival Gear for BSK Model

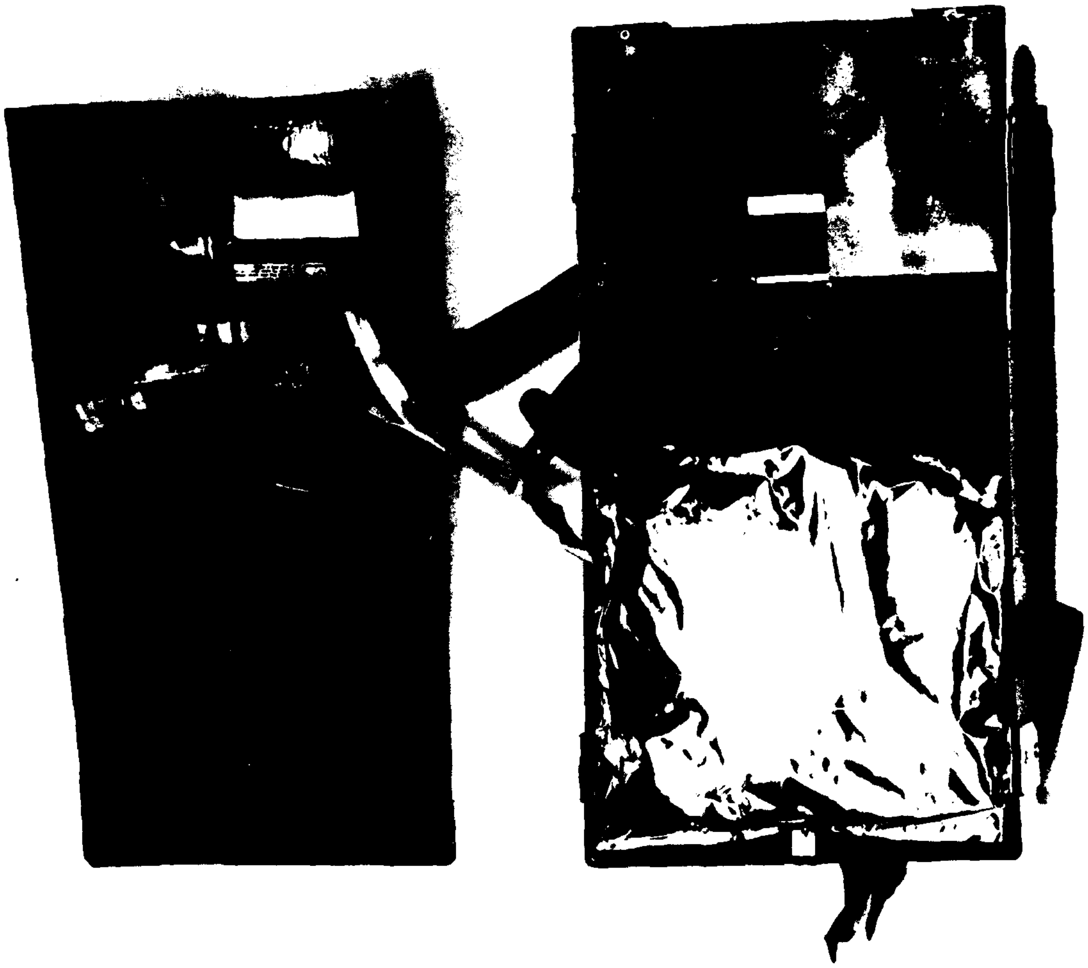

Figure 6. Stowed Survival Gear In BSK

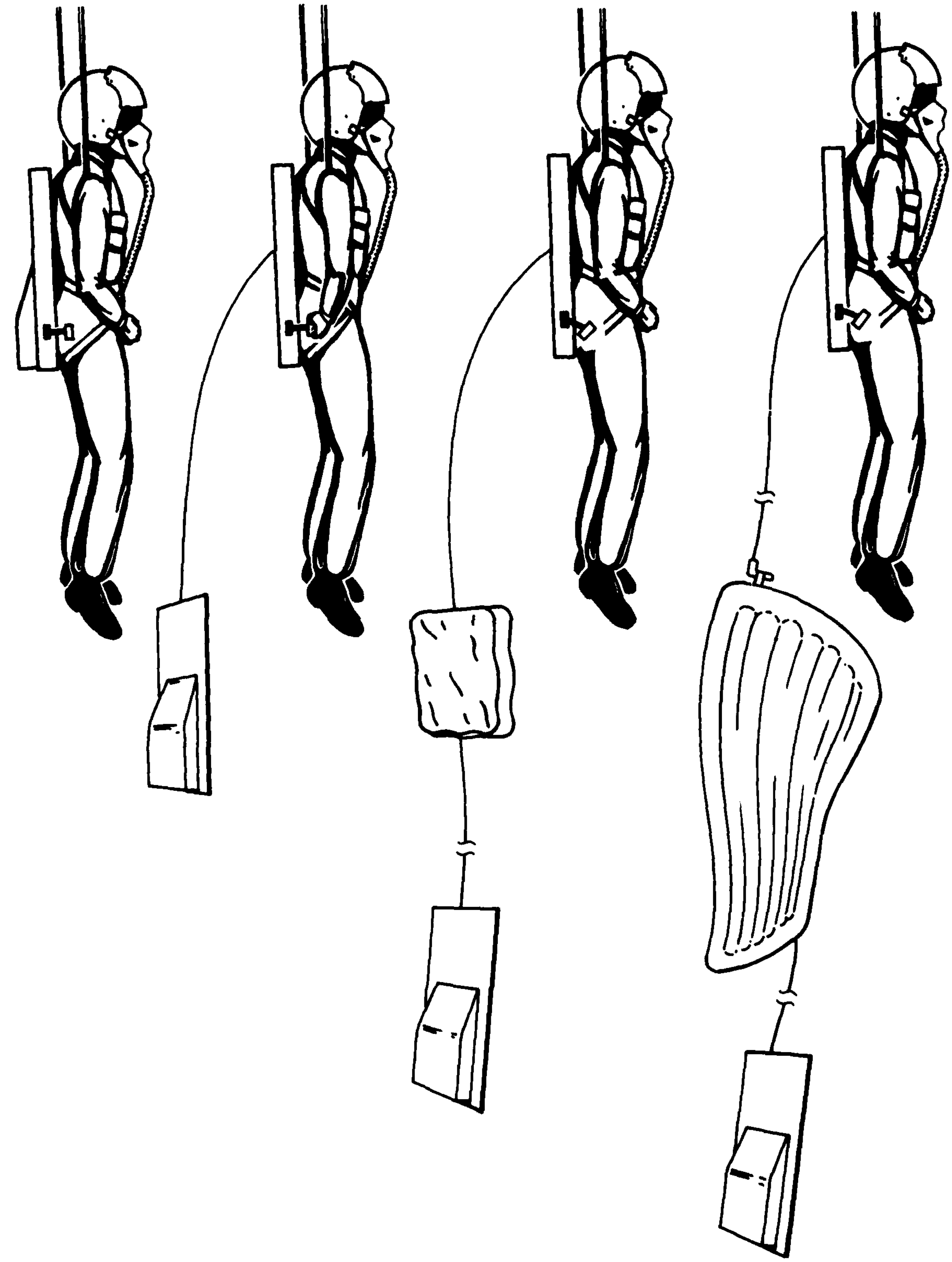

Figure 7. Liferaft Deployment During Parachute Descent

The overall placement of survival kit items is still being reviewed and it is likely that the arrangements shown in Figures 5 and 6 may change.

FUTURE EFFORTS

Further investigation and testing will involve the following:

- Liferaft deployment. The liferaft will be deployed from the BSK by human subjects during a simulated parachute descent. Liferafts will also be deployed by test subjects who are in water to simulate conditions of downed crewmembers who descend into water without having deployed the raft during parachute descent.

- In-water safety. Aside from in-water raft deployment, test subjects will help determine if the BSK hinders floatation, parachute disentanglement, breathing, etc.

- Non-ejection emergency escape. Human subjects carrying the BSK will exit aircraft cockpits to determine if the BSK hinders quick and safe escape.

- Seat-crewmember separation tests. These tests will investigate the ease of which the crewmember separates from the seat during ejection.

- Parachute opening shock. Drop tests using dummies will determine structural integrity of the BSK with its contents when subjected to 30 G shock loads. Also, the tests will show if the BSK could possibly contact and injure the crewmember (particularly, in the back of the neck or head).

- Parachute landing. Attention will be given to a possible injury-causing situation in which the crewmember falls on his BSK upon landing on the ground. Similarly, attention will be given to parachute "splashdown" (water entry) in which impact on the water might shove the BSK into the back of the crewmember's neck or head.

Based on test results, the experimental BSK models will be modified.

Testing during the upcoming phase of the BSK development will pertain mainly to BSK exterior configuration. Simultaneously, there are or will be efforts conducted within the Life Support Engineering Division to improve life support and survival equipment. This equipment can be stowed in the BSK. Such efforts pertain to emergency breathing oxygen equipment, liferafts, and miscellaneous survival gear. Discussions of such developments are beyond the scope of this report, but information should be forthcoming in future NADC reports.

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